Abstracts of Technical Articles from Bell System Sources

Notes on Radio Transmission.[1] CLIFFORD N. ANDERSON. Considerable data on radio transmission have been obtained the past few years in connection with the establishment and operation of various radio-telephone services by the Bell System. It is the purpose of these notes to present certain aspects of some of these data which may be of interest in the development of a general physical picture of radio transmission and in indicating the effects of disturbances accompanying storms in the earth's magnetic field.

The general results which are arrived at are:

1. Neglecting short time fading, the maximum field strengths received at a given point for frequencies up to at least 4 megacycles are in general agreement with those calculated by the inverse-distance law and the minimum field strengths (over-water transmission) are in approximate agreement with those calculated by the Austin-Cohen formula.

2. There appears to be a daylight absorption band in the neighborhood of 40 kilocycles (North Atlantic transmission) which reduces minimum daytime fields in that vicinity below the minimum limit given above.

3. The effect of solar disturbances is to increase the absorption to "sky wave" transmission throughout the entire radio-frequency spectrum generally and to reduce or eliminate the 40-kilocycle absorption band, thereby increasing daylight fields for transmission on frequencies in that vicinity.

Electrolytic Phenomena in Oxide Coated Filaments.[2] JOSEPH A. BECKER. A critical survey of the literature shows that the current through the oxides in oxide coated filaments is carried by electrons, negative oxygen ions, and positive barium ions. The proportion of current carried by each depends upon the exact composition and method of preparation of the oxide coating, on the heat treatment and on previous electrolytic effects. Presumably the conductivity is greatly affected by barium and oxygen dispersed through the oxide. New experimental results show:

[1] *Proc. I. R. E.*, July, 1931.

[2] *Trans. Electrochemical Soc.*, Vol. LIX, 1931.

1. For a particular BaO + SrO filament, the conductivity C was given by

$$1.71 \times 10^4 \epsilon^{-\frac{1.73 \times 10^4}{T}} + 5.55 \times 10^{-3} \epsilon^{-\frac{0.62 \times 10^4}{T}}$$

2. The current is proportional to the voltage only so long as the current is small; otherwise the products of electrolysis alter the conductivity.

3. Polarization currents are caused by the Ba and O which are produced by electrolysis. These currents decrease rapidly even at temperatures near 500° K., thus showing that Ba and O diffuse at low temperatures.

Recent Developments in the Operation of Overseas Radio Telephone Service.[3] F. A. COWAN. This paper outlines the status of the present overseas radio telephone services from the United States, discusses the disturbing factors affecting each type of circuit, and outlines the reasons why short waves have come to be considered the probable medium for future extensions. The causes of lost circuit time to these services are given in their order of magnitude as: adverse atmospheric conditions, operating adjustments, radio interference, line and equipment troubles, and unclassified causes. Adverse atmospheric conditions have been partially overcome by the use of directive transmitting and receiving antennas and automatic gain devices on the radio receivers. These arrangements, however, do not eliminate the lost time caused by magnetic disturbances directly in the radio path or by the phenomena known as selective fading. Magnetic disturbances usually affect radio transmission over an appreciable period and a chart is included which shows the average manner in which they affected the available circuit time for the year 1930. The time required for operating adjustments which include such items as line-up and talking tests, changing wave-lengths, etc., will always be a factor but improvement will undoubtedly come with equipment development and experience. Line and equipment troubles are almost insignificant by comparison with the other causes of lost time and are made so by careful design and maintenance and the provision of spare units. A chart is included which shows for the month of August 1930 a comparison of lost circuit time, by causes, between the European and South American radio circuits. A chart is also included which shows the results of frequency measurements made over the month of August 1930 on the 21420 kc. transmitting frequency from the WLO transmitter at Lawrenceville, New Jersey. It is of interest to note that at no time during the month

[3] In abridged form, *Elec. Engg.*, July, 1931.

did the transmitter deviate from its assigned frequency by more than ± .01 per cent, whereas the limitation specified by the Federal Radio Commission is ± .05 per cent.

On the Art of Metallography.[4] FRANCIS F. LUCAS. Photomicrographs showing the highest degree of resolution and detail as yet obtainable with the high power microscope illustrate the paper.

Of particular interest is the new theory of the cause of fatigue failure in hardened steel presented by Dr. Lucas as due to the presence of minute cracks produced during the hardening process.

These quenching cracks average 25 atoms in width and 1000 atoms in length.

A complete description of the use and potential resolving ability of the high power microscope leads up to the art of metallography and its value in the industrial field.

Announcement is also made of the new metallurgical equipment by means of which can be achieved crisp, brilliant images at twice the present limits of useful magnification. The order of resolution will be improved and better optical and mechanical means will be at the disposal of the metallographer.

Some Physical Factors Affecting the Illusion in Sound Motion Pictures.[5] JOSEPH P. MAXFIELD. The advent of sound pictures brought the physicist and engineer face to face with problems which lie in the field of art as well as in the field of material things. A study of the physical factors which underlie art would probably be lengthy although it is conceivable that with sufficient knowledge of these physical factors it might be possible artificially to develop high-grade artistic sound pictures. It was felt, however, that more useful information of immediate applicability could be obtained by attempting to control, under the conditions of photography and recording, those factors which determine an observer's interpretation of what he sees and hears when observing a real event. The artist and director must be relied upon for the art in the production and the engineer or physicist is required to record and reproduce the scene in such a manner that the illusion in reproduction transmits to the audience the artistry produced by the actor.

This paper therefore describes the results of an empirical study of methods of controlling some of the factors available to the engineer in

[4] Presented at N. Y. mtg. of *Amer. Inst. of Mining and Metallurgical Engineers*, February, 1931. Published in *Heat Treating and Forging*, July and August issues, 1931.

[5] *Jour. Acous. Soc. Amer.*, July, 1931.

sound recording and photography in such a manner that a pleasing illusion of reality is created in the theater.

A Device for the Precise Measurement of High Frequencies.[6] F. A. POLKINGHORN and A. A. ROETKEN. A description is given of equipment which has been constructed for the measurement of radio frequencies between 5000 and 30,000 kc. The equipment consists of a million-cycle quartz-crystal oscillator as a standard of frequency, means for producing harmonics and subharmonics of this frequency, and means for combining voltages of these known frequencies with a voltage whose frequency it is desired to measure so as to produce beat frequencies in successive stages, the beat frequency produced in each stage having one less digit than that in the preceding stage. A calibrated electric oscillator is used to measure the frequency of the last stage. An indicator gives the frequency of the unknown after a series of dial adjustments. The precision of a completed measurement is estimated at better than three parts in a million.

Radio Transmission Studies of the Upper Atmosphere.[7] J. P. SCHAFER and W. M. GOODALL. In this paper are given a number of measurements which show time variations in the virtual height of the ionized regions of the upper atmosphere. These measurements were usually made simultaneously on two frequencies, 1604 kc. and 3088 kc. Single frequency data are also given. The following are the main points of interest presented.

(1) The data indicate the existence of two distinct ionized regions or layers. The changes in virtual height are sometimes very abrupt. The existence of the lower layer even at night is indicated by an occasional return to low virtual heights during this period.

(2) Experimental evidence has been found of large retardations in group velocity near the critical conditions for which the waves just penetrate the layer to the point of maximum ionization. (Fig. 1) Absorption is especially marked at such times.

(3) Except at these critical periods the records for the simultaneous transmissions show that the virtual heights of the upper layer are greater for the higher frequency than they are for the lower frequency. This statement would probably hold for the lower layer but no evidence on this point is presented.

(4) In the discussion several possible methods of two-layer formation are suggested, one of which involves the formation of negative ions in the region between the layers.

[6] *Proc. I. R. E.*, June, 1931.
[7] *Proc. I. R. E.*, August, 1931.

Theoretical and Practical Aspects of Directional Transmitting Systems.[8] E. J. STERBA. This paper discusses some of the more important principles involved in the development of the directional transmitting antennas at present employed in the Bell System short-wave facilities. The theoretical performance of directive arrays is presented by means of various curves which have been obtained by integrations based upon Poynting's theorem. The details of the mathematical derivations are omitted for the sake of brevity, but the general procedure and the resulting formulas have been placed in an appendix. Various practical problems encountered in the development are described. These include antenna tuning procedure, transmission line adjustments, and sleet melting facilities.

Nature of Stimulation at the Organ of Corti in the Light of Modern Physical Experimental Data.[9] R. L. WEGEL. The active prosecution of a program for the study of deafness has arrived at a point where a correct understanding of the mechanism of hearing may be utilized with profit. A "theory" should not be regarded as an academic description in terms of mathematical symbols of what is conceived to be a correct and final solution of the problem. It should be regarded as a necessary correlation of experimental data. The "correctness" of the theory should be judged by its utility and as long as it satisfies all demands made on it there is nothing "wrong" with it. The most that can be asked of any theory is that new experimental data, as it appears from time to time, will modify the conclusions only in quantitative detail but not in its broader qualitative aspects. The principal value of a theory is in the practical use that can be made of it, the value of it as an intellectual exercise being negligible.

The "theory" of hearing which apparently is in accord with all experimental data, whether it be anatomical, physiological or physical, is that which in its rudimentary form is known as the Helmholtz theory. Owing to the existence at present of a large quantity of precise data, particularly of a physical nature, this theory has undergone considerable advance since the time of Helmholtz.

Briefly, this theory ascribes the principal part of sound analysis to the mechanical properties of the end organ. In order to accept the essential points it is necessary to be agreed on a limited number of specific points:

1. If the basilar membrane vibrates with sufficient violence the hair cells in the superstructure of the organ of Corti are stimulated; and

[8] *Proc. I. R. E.*, July, 1931.

[9] Read before the *New York Academy of Medicine, Section of Otology*, Nov. 14, 1930.

further if, in response to a sound, the basilar membrane vibrates more violently in one place than in another, the stimulation of the nervous tissue is greatest where the vibration is most violent.

2. The basilar membrane does vibrate in response to sound and does so differently at different frequencies. It is easily shown by an elementary theory of mechanics that all bodies of whatever nature, whether solids, diaphragms, membranes, rods or bodies of fluid, behave in this fashion. Theoretically, it is possible to describe a body which vibrates the same at all frequencies, but such a body is never found experimentally. This leads to the conclusion that the basilar membrane where the nerve terminals are situated is quite capable of performing an analysis of a kind of sound.

3. The vibration of the basilar membrane resulting from sound is greatest at the proximal end for high frequencies and at the distal end for low frequencies. In order to arive at this conclusion Helmholtz depended on purely mechanical considerations, which for any one familiar with this type of philosophy is fairly satisfactory. Histological examination of ears known to have lowered acuity in certain frequency ranges have shown this to be the case.

4. In the normal ear there is only one spot which vibrates sensibly in response to one pure frequency in the cochlea. This thesis is quite well established by measurements on masking of one pure tone by another, in which case it is found that one sound masks another more effectively when the frequency of the second is nearer the first.

5. The only sensible functioning connections between nerve cells of the spiral ganglion, either direct or indirect, through branching of the peripheral axones at the organ of Corti, are confined to near neighbors. This thesis is also established by the physical data on masking.

6. The minimum detectable change of pitch corresponds to a shift along the basilar membrane of the vibrating spot for a distance equal to the space occupied by a definite number, approximately constant, of ganglion or hair cells.

With these points taken for granted it is possible to describe the mechanism of hearing in its broader aspects and to calculate to an approximation the actual position on the basilar membrane at which different frequencies stimulate it and to calculate also the extent of the stimulating spot for each frequency.

Automatic Power Plants for Telephone Offices.[10] R. L. YOUNG and R. L. LUNSFORD. The nature of power requirements for telephone offices is discussed, with emphasis on continuity of service. Auto-

[10] In abridged form in *Elec. Engg.*, June, 1931. In complete form, *Bell Tel. Sys. Monograph* B-561, May, 1931 and complete with discussion in *Trans. A. I. E. E.*, October, 1931.

matic controls are indicated because of their more exact performance, with consequent reduction in variations and in interruptions and their saving in maintenance, particularly with 24-hour operation demanded. Developments are traced, showing an increasing trend toward automatic regulation and control of main power supplies, ringing and other signaling energy sources.

The development of "unit type power plants" for telephone offices is discussed and information is given on a number of standardized plants which operate upon a full automatic or a semi-automatic basis. These furnish power supply for manual, toll, and telegraph central offices, for magneto offices and for manual and dial system private branch exchanges, also for small dial system central offices.

Favorable operating experience points the way toward further introduction of automatic devices which will place most telephone power plants, except those in the larger dial system offices, in a position to operate themselves over considerable intervals of time.